

THE IMPACT EJECTION OF LIVING ORGANISMS INTO SPACE;

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Can natural processes blast living organisms into space? Although this may at first seem too far-out for a serious scientist to suggest, Dr. H. Jay Melosh, an Associate Professor of Planetary Science at the Lunar and Planetary Lab of the University of Arizona, finds that this is not as ridiculous as it may seem. Rocks ejected from the Earth by a giant meteorite or comet impact can carry microorganisms into space. Such microscopic Earth life would have an opportunity to colonize the other planets if it can survive the rigors of space until it falls into the atmosphere of a hospitable planet.

There is already evidence that some process can blast chunks of rock into space from the surfaces of the Moon and perhaps Mars. Some of these rock fragments go into orbit about the sun and eventually encounter the Earth, falling to the ground as meteors. A consortium of meteoricists announced the discovery of a meteorite from the Moon, AHLE B1005, several years ago at the Lunar and Planetary Science Conference in Houston. Other scientists feel that the long-known Ehergottite, Nakhalite, and Chassignite (SNC for short) meteorites originated on Mars.

How did these meteorites leave their parent planet? Volcanic eruptions, although they can hurl large rocks many miles, are not capable of ejecting material into space. Even the giant volcanic eruption plumes discovered on Jupiter's satellites Io are incapable of throwing solid rocks out of the satellite's gravitational field. Only the impact of a very large meteorite

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on a planet's surface is able to blast boulder-size rocks into space. The lunar meteorite was launched by the impact of a small asteroid whose diameter was at least the length of a football field (about 100m). The SNC meteorites, if they do come from Mars, could only have been launched by the high-speed impact of an asteroid or comet several miles in diameter. Although such large impacts are not common, even on the Moon or Mars, the cratered surfaces of these planets show that many large impacts have taken place over geologic time. One large impact every ten or one hundred million years would still eject enough of a distant planet's surface to explain the occasional discovery of a rock from its surface on Earth.

The discovery of rocks from other planets on Earth caused Dr. Melosh to wonder whether rocks from Earth might be found on the other planets. Giant impacts are well known on Earth. Louis and Walter Alvarez at the University of California at Berkeley, among others, showed that the Age of Dinosaurs was probably ended by a 7 mile (10 km) diameter asteroid that crashed into one of Earth's oceans. The scars of other giant impacts are recognized at Manicouagan, Quebec, Canada, and at Popigai in Siberia, among other places.

Dr. Melosh showed that a large impact ejects a thin layer of near-surface material in nearly its original state. Deeper-lying rocks are also ejected, but these are crushed or melted by the shock of the large meteorite striking the ground at high speed. The small quantity of unaltered surface material thrown off at high speed, however, is the most biologically active portion of

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Earth's surface. Although the accelerations at the time of launch are too high for multicellular organism to withstand (thousands of times larger than the Earth's surface gravity acceleration), microorganisms or bacterial spores might survive.

The Earth's atmosphere probably offers little impediment to the escape of high-speed surface rock fragments. Eugene Shoemaker, of the U. S. Geological Survey in Flagstaff, Arizona, showed that the 7 mile diameter asteroid that ended the Age of Dinosaurs must have blown the atmosphere aside for a distance of 250 miles (400 km) around the impact site. An atmospheric hole this big takes nearly a minute to close again. The high speed ejecta takes only ten seconds or less to leave the Earth's surface and fly free into space. The ejected surface rock fragments are thus long-gone by the time the atmosphere flows back over the impact crater.

Although this reasoning is theoretical, the undoubted presence of at least a few rocks from the Moon and perhaps Mars makes it plausible that, sometime in its past, the Earth suffered a number of impacts that lofted millions of tons of its surface rock intact into space. Many of these rock fragments would have been boulder-size, some as large as a Volkswagen (several meters). It is possible that dormant microorganisms or spores might survive inside these rocks, protected from radiation and extreme temperature changes. The vacuum of space could aid preservation by freeze-drying the microorganisms.

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What will eventually happen to these life-carrying Earth rocks? Most are doomed to spend geologic periods, tens to hundreds of millions of years, in space. Some will re-impact the Earth, others will impact the surfaces of airless satellites or asteroids at high speed, vaporizing their substance during the collision. A few, however, may eventually fall toward a planet possessing an atmosphere: Mars, Venus, or even Jupiter, Saturn or Saturn's large satellite Titan. Atmospheric friction would slow the entering rock and atmospheric drag forces would break it open. Earth organisms would then have the opportunity to colonize this new environment. Of course, it is most likely that they would find it inhospitable and perish.

However unlikely this chain of events may seem for any particular piece of Earth's surface rock, the total quantity of rock ejected from the Earth by large impacts is large enough that the scenario described above probably happened not once, but several times over the history of the solar system. If there is life on any of the other planets, a reciprocal process may already have brought samples of this life to Earth. Like the continental land masses on the Earth, the solar system may be divided into separate, but not wholly isolated, biological provinces. If living organisms are discovered elsewhere in the solar system they may thus turn out to have fundamental similarities to terrestrial life.